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Technical Letter
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Engineering and Design
GEOTECHNICAL ANALYSIS BY THE FINITE ELEMENT METHOD

1. Purpose

This engineer technical letter (ETL) provides guidance on the use of the finite element method in the analysis of problems in geotechnical engineering. This ETL is intended for engineers who are unfamiliar with the method, but who are interested in understanding its potential use in geotechnical engineering.

2. Applicability

This ETL applies to all HQUSACE elements and USACE commands having responsibilities for the design of civil works projects.

3. References

See Appendix A.

4. Background

a. Numerical technique. The finite element method (FEM) is a numerical technique which can be used to solve problems in geotechnical engineering. Computer codes based on the FEM have been developed to solve problems involving soil structure interaction, embankment construction, seepage, and soil dynamics.

b. Traditional methods of analysis. Traditional methods of analysis often times use techniques that are based on assumptions that oversimplify the problem at hand. These methods lack the ability to account for all of the factors and variables the de- sign engineer faces and may severely limit the accuracy of the solution. The finite element method can overcome many of these shortcomings, thereby offering many advantages over the conventional approaches. Accordingly, the FEM accounts for complex geometries, a variety of loading conditions, nonlinear material behavior, nonhomogeneous material distribution, and soil-structure interaction effects that are not accounted for in the simpler procedures. Unfortunately, the FEM is an underutilized technology in the design process because engineers believe its application is time consuming, expensive, and complicated. However, with recent advances in the hardware and software associated with modern digital computers, a properly conducted FEM analysis can be conducted rapidly and at a relatively low cost.

5. Objective

The objective of this ETL is to provide a basis for understanding what can be learned from finite element analyses, what skills are required for its application, and what resources in terms of time, effort, and cost are involved. The emphasis is on practical applications of the method. Appendix A contains information as to how the FEM can be used in soil-structure interaction, embankment construction, and seepage analysis. Appendix A includes discussions on the details of finite element modeling, case histories, and a section which will help interested engineers find further information on how the FEM can help in the analysis of their problems.

FOR THE DIRECTOR OF CIVIL WORKS

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